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HOMOGENEOUS CONTENT IN THE MEASUREMENT
OF CONTINUOUS MEMORY PROCESSES.¹

BY PROFESSOR CARL E. SEASHORE,
State University of Iowa.

Experimental pedagogy has not yet found itself. Here and there a crumb, the by-product of a theoretical investigation in psychology, has been proffered only to be lost in the scramble for its absorption. Of the few investigations which have been undertaken from the avowedly pedagogical point of view in experiment some are of questionable scientific value because the experimenter had only a superficial view of the elements in his problem, and others have failed because an unreliable psychological method was used.

To experiment in psychological pedagogy, the experimenter must first of all have psychological technique in hand. As experiment in psychology had to wait for the development of experiment in physics, chemistry, and biology, so education has to wait upon the development of experiment in psychology. Experiments in pedagogy must be conducted with a psychological technique. The psychological laboratory should furnish the pedagogical laboratory with methods and tested apparatus. In this respect, the relation of education to psychology is analogous to the relation of psychology to physics. So far as possible, the psychologist draws upon physics for the physical principles which enter into the control of his stimuli and measuring apparatus; and the educator should draw upon psychology for the psychological principles and aids which come into operation in his experiments.

The recognition of this is the first step out of the haphazard, hit-and-miss procedure of experiment in education. I would not for a

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moment belittle the simple direct observation which does not deserve the name of experiment but leads to insight. My contention is that the development of a successful psychological method is enough of an object in itself and the solution of a pedagogical problem is enough of an object in itself. If we take the two together we have two variables. The American Association stands for the principle of taking only one variable at a time, and Education is to be congratulated on being put upon the same basis as the other sciences in this respect.

Only a very small number of the astronomers who rise above our intellectual horizon are called upon to invent telescopes and tables of logarithms. But, of course, the educator to-day puts the beseeching question to the psychologist—where are your telescopes and where are your logarithms? And the psychologist replies, "Come over to Damascus and help us."

In accordance with this attitude, I have chosen to speak of something which is not new, but rather something on which I can speak from conservative experience. In my work on a method of measuring mental work, published eight years ago,¹ in Miss Kent's and my work on periodicity in mental work,² published three years ago, and in Dr. Fracker's recent work on the transference of training in memory,³ as well as in a lot of minor researches, there has gradually developed in my laboratory a method, or a system of methods, of using homogeneous content in long protracted memory tests. It is not newness, nor is it originality that justifies my speaking of this question, but rather the feeling that this method is eminently serviceable and should replace some of the cruder methods which are still in vogue. Homogeneous sensory stimuli have, of course, been in use by many others.

For rough purposes it may suffice to know that John can commit to memory a piece of poetry in two minutes, William in three and Peter in ten. But the real questions are, how did each one proceed with reference to imagery, associations, span of attention, order of repetition, special clues, memory aids, etc.? Wherein does the advantage of one procedure over another lie? What is the nature of Peter's handicap? What specific deductions may we make with reference to the improvement of nameable factors in the process?

Such memory contents as poetry, prose, numbers, nonsense syllables.

¹ Seashore, 'A Method of Measuring Mental Work: The Psychergograph,' *Univ. of Iowa Stud. in Psychol.*, III., 1-16.

² Seashore and Kent: 'Periodicity and Progressive Change in Continuous Mental Work,' *Univ. of Iowa Stud. in Psychol.*, IV., 46-102.

³ Fracker: 'On the Transference of Training in Memory,' *Univ. of Iowa Stud. in Psychol.*, V., 56-102.

bles, etc., do not answer the purpose. They cannot furnish homogeneous units. They involve distracting associations. Their only unity is in the continuity of flux. Only the gross total can be measured. There can be no fractionating of introspection. We cannot know what we are dealing with. Yet such memory contents seem to enjoy the sanction of good patronage.

To experiment seriously on memory, we must keep in mind the elements of the process—impression, retention, reproduction, and association—and control these so that we may repeat and describe each one. We must know the content and the magnitude of the impression, the duration and the degree of retention, the manner and the conditions of the reproduction, and the types of association. This can be done only if we use simple and homogeneous content or objects.

I commend a plan that answers this purpose. It enables us to take simple and homogeneous memory objects from any sense, and from any particular attribute within each sense, and to continue with the same material for any desired length of time,—hours, days or weeks.

Let me illustrate it in a simple form. Suppose that we take for our memory objects four tones which differ in pitch only, *e. g.*, the individual tones in the major chord. These may be struck upon the piano, following the beat of a metronome, at the rate of one tone per second in any one of twenty-two different orders, for example, *e, c, g, c'*; *g, e, c', c*; etc. The impression thus takes four seconds. The next four seconds are allowed for reproduction. This is continued indefinitely—four seconds for impression and four for reproduction. In the reproduction, the observer is required to give the order of the tones in the last group *but one*. This gives a specific period for retention of a clearly definable content: one group has to be retained while a new one is being received and the foregoing one is reproduced.

In this manner, the process may go on without interruption and under constant conditions as long as may be desired. The observer never knows in what order the tones may be given, therefore, his task is constant. The reproduction may take the form of simply naming the tones, or the experimenter may keep the record by checking on a mimeographed sheet which also serves as a guide in sounding tones.

The method just illustrated requires no apparatus other than a piano and a metronome. But ordinarily we find it convenient to use apparatus which operates more automatically and does not tax the experimenter or place so much responsibility upon him. My multiple recorder answers the purpose of a recording instrument under a great variety of conditions. It is a sort of universal recording apparatus in

which the record is made by a series of fountain pens operated electrically and writing on a telegraph tape. The stimuli and the responses are shown in the same tracing.¹

Let us see what a richness of possibilities we have in this plan. In the first place, we may select any particular sense imagery and any attribute of that image. I have illustrated the case of pitch in auditory memory. In the same manner we might have used a single tone and simply varied its strength, the memory being for intensity of tone. Or we might have selected a series of tones varying only in duration, or in direction. In visual memory, we might use colors, grays of different brightness, form, distance, or movement as seen. In tactual memory, we might use different degrees of pressure, different locations of touch, or different kinds of contact. In kinæsthetic imagery, we might use differences in weight, resistance, or movement of limbs. Many other variations are possible both in these and the lower senses.

In the second place, the difficulty of the task may be varied by varying the number of units, the order of impression and reproduction, the time, the mode of reproduction, and the relative difference in the stimuli, in order to adapt the test to differences in age, ability, practice, memory type, etc.

For normal adults, four units seem to be the most favorable number to use. With young children and with adults of inferior ability, it is ordinarily better to use only three. Three units may be sufficient for any observer unless one plans to allow room for long practice. The number, of course, depends upon the order of impression and the method of reproduction.

For long series and with normal adult observers, the order illustrated in the example I gave of tones is very satisfactory, particularly in that it favors the introspective analysis. This order is the one which I would advocate for most purposes, especially where practice is a factor and introspection is essential.

If a single easy test is wanted, we may simply give eight or ten objects in succession, at a given rate, and then require the observer to reproduce this series immediately. Such a series should, however, not contain more than four units. Thus, from a series of colors, *r*, *g*, *y*, *b*, we may arrange a group like this—*g*, *r*, *b*, *g*, *y*, *r*, *g*, *r*. The observer has to report the order in which the colors are shown.

It is very important to control the time, not only in order to know the duration of the processes but primarily to secure check on tendencies to repeat, rest, and associate. One unit per second is a favor-

¹ *Op. cit.*, p. 8 ff.

able rate both for impression and reproduction. The reproduction is usually bunched and given fast in order to secure rest, or in order to get it in after a moment of hesitation. It should be limited only in the total time for the group, not in the rate.

Much depends upon the mode of reproduction. Names or numbers may be assigned to the stimuli. One may avoid the use of names, *e. g.*, by using a simple form of reaction, or some gesture. Or the reproductions may be made in any other arbitrary terms that may have been agreed upon. Then, again, most of the stimuli that commend themselves for this work may be adapted for repetition or even for detailed reproduction. Thus, in the pitch memory first mentioned, the observer might sit at a second piano and reproduce memory groups by striking the keys in the required order. Singing, humming, or whistling might be substituted for the piano sounding.

Ordinarily, we must assume that the units are so chosen that the discrimination can be made without failure in attentive perception. The observer must familiarize himself with the stimuli before the memory test can properly begin. But the experiment may readily be complicated by introducing memory for detail. For example, suppose that the observer has before him a chart of the fifty Hering grays. Three or four unmistakably distinguishable ones of these are selected afresh as stimuli for each group and the observer is required to indicate the four as accurately as he can on the chart by pointing. The same principle may be applied to other sense stimuli as well.

To sum up, among the merits of this plan are the following:

1. It provides homogeneous and relatively simple memory objects. It gives us memory for color, brightness, pitch of tones, intensity of tones — in short, sensory memory — but, in any experiment, one and only one sensory attribute is varied. Contrast this with the use of poetry, numbers, etc.

2. It enables us to select any desired type of memory object and to adhere to that consistently.

3. It enables us to continue a memory task for any length of time with the same content and with the same degree of difficulty except for fluctuations in subjective efficiency and for traceable adaptation through practice. It furnishes us an intellectual tread-mill.

4. It enables us to vary under control the impression, the retention, the reproduction, and the association.

5. It enables us to get a detailed and permanent record.

6. It gives most favorable conditions for introspection of association and imagery. The uniformity of the process adapts it for fractionating.

7. It promises to be of value in applied psychology. Not only memory itself, but general mental conditions may be investigated through the medium of memory, *e. g.*, fatigue, adaptation, practice, transference of training, comparison of types, comparison of conditions, division of energy, and attention.

METHODS OF DETERMINING IDEATIONAL TYPES.

BY DR. STEPHEN S. COLVIN,

University of Illinois.

Although the existence of the mental image was pointed out definitely by Aristotle in the *De Anima*, the first attempt to accurately describe its nature was made by Fechner¹ in his comparison of the mental image with the after-image. With great introspective skill he analyzed his own visual imagery and found it to be extremely weak and indefinite in comparison with the after-image of his experience. Weaker still was his ability to call up mental images of other sense departments than those of vision. Auditory mental images he found practically non-existent. The voices of friends he could not as readily recall as he could their faces. Simple melodies he found it possible to remember, especially with the aid of his own voice and the movements of his speech-organs. He further reported that it was impossible for him to recall in memory images of taste or of smell.

Fechner did not rely entirely on his own introspections, but by questioning others discovered that his mental imagery was not as vivid as that of some of his acquaintances. He states at some length the replies of six different persons, four of whom were university professors, one of whom was a writer, and the sixth Fechner's wife. These were questioned in regard to the relation between the after-image and the memory image and they were asked to compare the two in respect to color, definiteness, voluntary control, position in space, etc. Fechner reports that his wife possessed vivid imagery of hearing, taste and smell as well as of vision.

Francis Galton² some twenty years later took up the problem practically where Fechner had left it. He attempted to discover by means of a set of questions the characteristics of mental imagery of a much larger number of persons than had been the subject of Fechner's pioneer investigation. He began by questioning men in the field of science, whom he found to be singularly lacking in all mental imagery. Extending his inquiries more generally to persons of both sexes and of various ages, he found some possessed of extremely vivid visual

¹ *Elemente der Psychophysik*, 2. Aufl., 469-491.

² *Inquiries into the Human Faculty*, 1883.

images, brightly illuminated, clearly outlined, and distinct and rich in coloring. Galton's inquiry, like that of Fechner, concerned chiefly the visual image. It, however, touched upon sound, smell, taste, dermal imagery (touch, pain, temperature) and organic imagery (hunger, fatigue, and other general bodily conditions).¹

In reviewing the contribution of these pioneer investigators in the field of mental imagery, we should also keep in mind the work of the mental pathologists, chiefly Charcot, who emphasized the existence of distinct ideational types, as revealed in his clinical investigations. Charcot² and his pupil Ballet distinguished the visual, acoustic, motor and mixed types. These types were further emphasized by Taine, Ribot, Binet and others. The literature on aphasia is especially significant in this particular.

An impetus to the study of motor and other verbal types in distinction from concrete imagery was given by Stricker³ and Egger,⁴ and taken up later by Dodge.⁵ Stricker, who seems to have taken his own type as universal, maintained that no one has definite acoustic or visual imagery of words, but that persons think in motor speech imagery. Egger, on the other hand, likewise generalizing from his own experience, was equally positive that in thinking we normally hear the cadence and rhythm of our own voices, and that this is the true inner-speech. Although Dodge reported that at times he thought in concrete visual imagery, as for example, when he was planning a piece of apparatus, he generally thought in words and pronounced these to himself, but without any auditory picture of these. His inner thinking appeared to be thoroughly speech-motor, and was not accompanied by hand-motor imagery. Dodge reported further that he possessed very weak acoustic imagery—that he could not recall voices, nor sing. This lack of acoustic images appeared to be largely a matter of inheritance, since in this respect he was similar to his relatives. Dodge's work clearly indicates the fact that a person may be speech-motor without being hand-motor and that the classification made by Charcot, which held to a single motor type, was too inclusive. Dodge's introspections also indicated that a person may possess a vivid type of imagery, which, however, may not be employed in ordinary thinking to any extent.

¹Galton's questionnaire covers somewhat over two pages, and is given in the appendix to his previously cited work, pages 378-380.

²*Leçons sur les maladies du système nerveux.* (1886-1890.)

³*Die Bewegungsempfindungen*, Wien, 1871. Also *Studien über das Bewusstsein*, Wien, 1879.

⁴*La parole intérieure*, Paris, 1881.

⁵*Die motorischen Wortvorstellungen*, Halle, 1890.

One of the most important discussions in recent years on the various ideational types is that of Segal,¹ who maintains that the conclusions reached by Charcot and others as to the existence of sharply distinguished ideational types is not altogether correct. Segal observes that not all those who possess intense visual imagery see all the words that they employ in thinking. Indeed such a type of thinking is exceptional and a person may, as Meumann has pointed out, for one purpose think in concrete visual imagery, while for another purpose he may think equally well in acoustic or motor imagery. Individuals apparently think visually concerning concrete objects, and in acoustic-motor terms when they employ words. For these reasons, Segal concludes that the whole doctrine of distinct types is untenable, and that the qualitative conception of ideational types must be abandoned for a quantitative distinction. Most persons belong to a mixed type, and perhaps possess greater vividness of imagery in one direction than others, but are not for this reason confined to one type of thinking. It is not to be concluded that because a person generally thinks in one kind of imagery this is due to the fact that this type of imagery is exceptionally vivid. It is evident that the majority of the perceptions which arouse our attention and are significant for us are visual, and it is, therefore, not remarkable that our thought material should be visual. Segal further urges that a person may be visual for one kind of material and perhaps motor or acoustic for another, and that, therefore, the type must be considered as relative to the material employed. Baldwin² remarks that for him "German is speech-motor and auditory, having been learned conversationally in Germany, while the French, which was acquired in school by reading and exercise writing, is visual and hand-motor." In this connection it may be said that in a series of experiments recently conducted in the psychological laboratory at the University of Illinois, it was discovered that the method of learning a series of words by one of the subjects observing, varied according to whether the words were presented in a regular or mixed order, in one instance the learner using visual imagery, in the other acoustic-motor.

Considerations like the above lead clearly to the conclusion that the attempt to determine absolute ideational types is hardly possible and that the best that can be done is to determine the predominating type for a certain class of sensory or verbal material.

The problem of determining ideational types is, however, further

¹ 'Ueber den Reproduktionstypen und das Reproduzieren von Vorstellungen.' *Archiv f. d. gesamte Psychologie*, XII., 1908, 124-345.

² 'Internal Speech and Song,' *Philosophical Review*, 1893, II., 385.

complicated by the fact that the methods generally employed are defective in many important respects, and often lead to results so contradictory as to be practically worthless.

Doubtless the most reliable method is introspective analysis. Such attempts as those of Fechner, Galton, Stricker and Dodge, already referred to, as well as that of Wilfred Lay¹ are exceedingly instructive and give most valuable insights. They are, however, studies in individual psychology and care must always be taken not to come to general conclusions, as, for example, Stricker has done, holding that the individual experience is typical. Fechner's questionnaire method, as developed by Galton and employed by others, has the value of bringing together mass results of introspective analysis, and it thus avoids the error previously spoken of, but it is open to other and more serious objections unless employed with the greatest of caution.² When used with subjects not skilled in introspection, I am convinced that even such a carefully prepared questionnaire as that used by Titchener may give the most misleading results.

Numerous objective methods for determining ideational types have been from time to time devised and employed with fair success. The most important feature of many of these is not the numerical results, but rather the introspective analyses by the subjects of these tests. These introspections, like all subjective analyses, depend, of course, for their value on the ability of the observers to get at their own states of consciousness. For the most part such objective tests as rely largely on the observer's introspection, are, therefore, chiefly of value when employed in testing small groups, and with skilled laboratory subjects. As mass tests their value is much less.

As tests of this type may be cited the 'word method' described by Titchener (*Experimental Psychology*, Volume I., pt. II³, pages 394-395). This method, as used by Kraepelin, requires the observer to write out a list of objects distinguished by their color, and a second list distinguished by their sound. An equal time is given for each list, and the subject that succeeds better with the first than with the

¹ 'Mental Imagery Experimentally and Subjectively Considered.' *PSYCH. REVIEW*, Monograph Supplements, II., No. 3 (1898). For his introspective analysis see particularly pages 32-47.

² An excellent statement of the value and limitations of this method of getting at introspective facts is given by Titchener, *Experimental Psychology*, Vol. I., pt. II., pages 387-390.

³ Titchener here conveniently describes a considerable number of tests that he has taken from the literature and in some instances modified to suit the needs of laboratory practice.

second is taken to be a visualizer, while the person who gets better results with the second is held to be of the auditory type. It is quite obvious that the subject may in writing this list have no concrete imagery at all. He may be merely relying on verbal imagery. In this case no conclusions can be drawn from the list of words as to the manner in which he thinks them. For example, the word whistle may be put in the list of auditory objects. Yet the imagery behind it may be entirely visual or motor. On the other hand the word rose may be auditory or motor, although it may be included in the visual list. In verbal imagery there is a slight possibility of judging from the content of the word the type of imagery employed in thinking it.

Secor employs the word method as follows. A number of words are written on slips of paper. The observer glances at these and immediately records the verbal image aroused, and the further imagery that may develop. His type of imagery is then determined by the per cent. of visual, auditory, motor, pressure and other images suggested. A similar list is given with auditory presentation and the two series compared. Obviously the value of such an experiment depends largely, first upon the care of the experimenter in selecting the word series, and secondly on the skill of the observer in being able to detect and record the flight of his imagery. If properly conducted, however, this test has decided merits. Similar to Secor's method is that of Dugas,¹ who determined the memory type by dictating words and getting from the subject a report of the associations aroused.

The methods of Binet and of Cohn of the 'letter squares,' carefully described by Titchener,² likewise have their chief value in the introspections of the subject. The letter squares, however, involve an important principle for the objective determination of visual imagery in that they present when given to the subject visually an opportunity to localize a particular letter in a certain place in the square and to reproduce it in its place on a similar blank square. As the correct placing of the letter is dependent to a considerable extent on the ability of the observer to visualize the square, high success in this direction would probably indicate considerable concrete visualizing ability.

Binet's method involves a further principle for determining ideational types. This principle rests on the assumption that the manner of presenting the material favors the visual type when the presentation is visual, the auditory type when the presentation is oral, and the motor

¹ *Recherches expérimentales sur les différents types d'images.* *Rev. Phil.*, XXXIX., 285-292, 1895.

² *Op. cit.*, pages 369-400.

type when the presentation is motor. A very common method of determining whether a given person is visual or auditory has been to test his ability to learn a series of words, for example, by seeing them, and to compare this with his ability to learn them when he hears them read and pronounced. Binet's method involves further the testing of the motor imagery by the experimenter guiding the hand of the blindfolded subject over a series of nonsense diagrams. It is quite obvious that a test like this can give but slight evidence as to the predominating type of imagery possessed by the subject of the experiment, since the three tests are by no means comparable. It is quite clear that the motor is so unlike the visual and auditory both in the material presented, and in the general condition of the presentation, that it would be useless to attempt a comparison of the relative strength of imagery of the subject on such a basis. It may, however, seem possible to make the conditions of visual or oral presentation practically identical in all respects except the one in point of calling up visual or auditory imagery. This identity of conditions, however, is difficult to obtain. Often the material presented visually is also simultaneously presented, while from the nature of the case the material which is given in auditory presentation must be presented successively. If, however, this difficulty is overcome by giving the visual material in successive presentation another difficulty exists when the material is other than single letters and figures. If the material, for example, is words or syllables the question at once arises as to whether the orally presented material should be simply pronounced or spelled in order to make it comparable with the visually presented material.¹ Further, it must be remembered, it by no means follows that because material is presented visually it must be learned with visual imagery, or orally it must be learned with auditory imagery. The translation from one sense department to another is often very rapid and the auditory or motor-minded person may reform material presented visually with practically no loss in mental efficiency. At the best, attempts to determine individual ideational types in terms of the method of presentation of the material are valuable only in showing that one subject is superior to another in a certain type of imagery, but not in deciding which type predominates in a given individual.

¹ This simple method of procedure is employed by Hawkins in his experiment on memory types, *PSYCHOLOGICAL REVIEW*, IV., 1897. In order to determine which was the stronger, visual or auditory memory, he presented to school children two groups of names of ten words. The first group was read at the rate of one word every two seconds. The second group was written on the blackboard and covered. Each word was then uncovered at the rate of one every two seconds.

Meumann² discusses at some length two objective methods of determining ideational types, namely, the Method of Distraction (*Methode der Störungen*) and the Method of Helps (*Methode der Hilfen*). The former method consists in giving the observer a definite memory task and measuring the exact time that is required to perform it. Then various distractions are employed, so chosen as to serve as hindrances for various types of ideation, and from the effect of these on the results of the learning, the type of the observer is determined. It is assumed that the auditory type is more easily distracted by auditory stimuli, the visual by visual stimuli and the motor by an interference with 'inner-speech.' The visual type, on the other hand, should not be greatly affected by the interference with inner-speech. The Method of Helps is intended to increase the effectiveness of learning. The visual type is aided by the spatial arrangement of the material presented, but for the auditory type this arrangement may even prove a hindrance to the learning. The auditory-motor type is aided by the subject pronouncing the words seen or drawing them with pencil or finger.

The foregoing assumptions are in part true, but they doubtless contain certain fallacies as methods for determining the ideational type of an individual. In the first place it must be remembered that the method of distraction may lengthen the time of learning or reduce its correctness simply, or largely, by taking away the attention of the subject from the learning and not by inhibiting the mental imagery employed in the learning. This may be illustrated by citing the experiments performed by Binet and later by Meumann on the mathematical prodigy, Inaudi. Binet had Inaudi sing a tone during his calculation. This resulted in lengthening the time Inaudi employed in his operations. Meumann had him hold his tongue between his teeth, to interfere with his 'inner-speech.' This lengthened the time of Inaudi's performance nearly three-fold. It is quite obvious that this result might have been due, in part at least, to distracted attention, and not simply to the inhibition of speech-motor processes. Meumann found that Inaudi was not disturbed by the tick of a metronome. It would not be safe, however, to conclude from this fact alone that Inaudi was predominately motor and not auditory. Such a conclusion could be safely drawn only when the auditory and the motor distrac-

² *Über Ökonomie und Technik des Lernens*, Leipzig, 1903. See also the first volume of Meumann's *Vorlesungen zur Einführung in die Experimentelle Pädagogik*, chapter X, for an extended discussion of methods for the determination of ideational types.

tions were quite comparable in all respects except in their quality. To take another example, obviously an extremely bright light would be a greater distraction than a noise of moderate intensity, but it would be very difficult to determine whether the tick of a metronome was more of a distraction, apart from its quality than, for example, the rhythmical appearance of a colored light on a screen. Unless these distractions were properly equated no valid exclusions as to the type of the subject could be made.

The fact that a distraction may merely cause the falling off of the attention given to the task in hand, and not in any way interfere with the use of imagery employed in solving the task, is well illustrated by a series of experiments just concluded by the department of psychology at the University of Illinois. A group of school children were tested in learning nonsense syllables, under normal conditions, and also with various aids and distractions. It was found that one of the greatest distractions, especially for the younger pupils, consisted in requiring them to learn the series with folded hands. This distraction was greater than that of holding the tongue between the teeth in many instances. It might be inferred from the test in which the learning fell off while the subject held his tongue between his teeth, that the result was due to an inhibition of the speech-motor imagery, but it would be difficult to conclude from the fact that the folded hands was accompanied by a falling off in learning that this result was due to an inhibition of the hand-motor imagery, especially since, when the children wrote the words seen, this procedure proved in most cases a hindrance to learning. The falling off in the learning is rather to be attributed to a distraction of attention in the case of the test with the folded hands; it may also be that a similar result when the tongue is held between the teeth is due to a like cause, and not to the inhibition of the speech-motor imagery.

The method of helps is open to an objection similar to the foregoing as a means for determining ideational types. This point is well illustrated by the experiments of W. A. Lay¹ and Itschner.² Lay gave school children words to learn under various conditions. They were heard without vocalizing, heard and pronounced in a whisper, heard and pronounced aloud; they were also seen under similar conditions; they were likewise seen and copied. He concludes from this that because vocalization and copying are aids in learning, children are largely speech-motor and hand-motor.

¹ *Führer durch der Rechtschreib-Unterricht*. Wiesbaden, 1899.

² 'Lays Rechtschreib-Reform.' *Jahrbuch d. Verein für wis. Päd.*, XXXII., 1900.

Itschner, who repeated Lay's experiments, disagrees with Lay as to the interpretation of the favorable effects of writing the words presented. Itschner does not attribute this effect to the motor ideas in writing, but to better attention and comparison that accompanies the writing. In other words, much of the favorable effect that goes with various aids in learning is not due to a facilitation of the ideational processes employed in the learning, but rather to increased attention and to other general conditions of learning.¹

Cohn² employed the method of helps and hindrance, presenting twelve letters arranged in four rows and learned under the following conditions: 1. Read aloud. 2. Studied with suppressed speech movements. 3. Read during the repetition of a vowel. 4. Read during the counting of numbers from one to twenty. 5. Studied during the reciting of a complicated series of numbers.

The subject was judged as acoustic-motor or as visual by comparing (1) and (2) and also by noting what effect the hindrance in (3), (4), and (5) had.

The letter squares test of Cohn as employed by Titchener³ is as follows: The observer reads the consonants of the letter square aloud, twice over in the first test. In the second test he studies the letter square at the same time continuously, sounding the vowel *a*. It may be easily seen in the light of the above discussion that the fact that the subject may do better with the first than with the second test would by no means necessarily indicate that he was predominately speech-motor rather than visual. It seems quite certain that the complementary methods of helps and of hindrances can, at their best, serve merely to evaluate favorable conditions of learning; they cannot, however, pronounce finally on the ideational type of the learner.

The Method of Style as employed by Fraser⁴ and Wilfred Lay⁵ attempts to deduce the type of imagery of an author from his writings. Lay counted the consonants in eight pieces of literature, classifying them under the heads of liquids, mutes, silibants, fricatives and semi-vowels. He concludes "that the poet whose rough consonants are greatly in

¹ In this connection see Pohlmann's comment on Lay's experiment. *Beiträge zur Lehre vom Gedächtnis*, page 141, footnote.

² 'Experimentelle Untersuchungen über Zusammenwirken des akustisch-motorischen und des visuellen Gedächtnisses,' *Zeitschrift f. Psychologie*, 161-173, XV., 1897.

³ Titchener, *op. cit.*, pp. 399-400.

⁴ 'Visualization as a Chief Source of the Psychology of Hobbes, Locke, Berkeley and Hume.' *American Journal of Psychology*, IV., 230, 1891.

⁵ *Op. cit.*

excess of the average has either a less sensitive 'ear' than the ones whose liquids are most numerous, or uses them as an expression of strength. Now an 'ear' in the sense above used means the possession of mental imagery of the auditory kind." I do not believe that this conclusion is at all necessary. The writer, as far as he can discover, has never had in his whole experience a genuine auditory image, and yet he is quite capable of 'feeling' the distinctions brought out by Lay. For him, however, it is entirely a kinæsthetic affair. It is probably, however, a valid conclusion that a person who has such an 'ear' as Lay discusses is possessed of either a good auditory or motor ideational type, or both.

Lay further, in studying several literary masterpieces, noted the various kinds of imagery that were awakened in his mind in reading the lines. This procedure, however, cannot give any conclusive insight into the types of concrete imagery used by the writer, since, as has been previously said in this paper, it is impossible to judge with any great degree of certainty from the content of the word to the imagery in the mind of the person using it. Lay, for example, cites as a case of auditory imagery this from Tennyson:

"Each of whom had broken on him
A lance that splintered like an icicle."

For me this is visual and motor. Lay cites, "And *shook* his drowsy squire awake," as an instance of motor imagery. To many, I am sure, this would present merely a visual picture. I do not find that the expression 'made her *cheek burn*' calls up a thermal image, or that the verse, "On either shining shoulder *laid a hand*" is for me tactile.

The assumption that the content of a word as determined by the experimenter gives an index of the imagery in the mind of the observer or author, is at the basis of certain phases of the investigations of Netschajeff¹ and of Lobsien.² These investigators tested school children, using, among other material, words such as rough, cold and heavy, to test their dermal imagery; sorrow, joy and doubt, to test their emotions. The writer some years ago tried a similar experiment. By studying the compositions of school children he tried to conclude as to the nature and development of their imagery during the school years.³ I am still inclined to think that such studies may

¹ 'Experimentelle Untersuchungen über Gedächtnisentwicklung bei Schulkinder,' *Zeitschrift f. Psychol.*, XXIV., 321, 1900.

² 'Experimentelle Untersuchung über die Gedächtnisentwicklung bei Kindern,' *Zeitschrift f. Psychol.*, XXVII., 34, 1902.

³ 'Imaginative Elements in the Written Work of School Children,' *Ped. Sem.*, 1906, XXIII., 84-93.

indicate something, but they are far from being an adequate test for the ideational type of the subject.

Lay, in connection with his study of the style of various authors, observed with care the flight of his own mental imagery, classifying it with great minuteness. This method, however, is purely subjective and depends entirely for its value on the observer's skill in introspection.

One of the most fruitful methods of getting at the ideational processes of an individual is by taking note of characteristic errors made in memorizing various kinds of material. Meumann¹ observes that the visualizer confuses like appearing but different sounding letters, syllables and words, while the auditory minded subject confuses like sounding letters, etc. Féré² pointed out this fact when he called attention to a mistake he had made in a report on an autopsy. He wrote *poumon trois* for *poumon droit*. He attributes the mistake to a similarity in the motions necessary to articulate the two sounds, however, rather than to their mere similarity in sound.

Pedersen³ tested school children with selected words from an English dictionary. These words were of seven letters each and those devised to test visual memory were of such a nature that the spelling and pronunciation did not agree (*e. g.*, borough, fifthly, arights). The acoustic memory was tested with words in which the spelling and pronunciation did agree. Pedersen observes that the acoustic child is likely to confuse like sounding letters such as *c* and *s* and *b* and *p* and to omit silent letters. It seems quite evident that errors of this character may distinguish an auditory or motor minded person from a visual minded, but it cannot throw light in itself on the question as to whether the person is auditory or motor in his ideational processes.

It has further been observed that the visual minded makes less mistakes in learning consonants, the auditory in learning vowels, and that the visual succeeds better when memory for spatial localization is involved than does the acoustic-motor type, while the latter succeeds better when the presentation of the material is accompanied by rhythm and accent.

Among other aids for determining ideational types, which may be constructed into separate tests, or used in connection with various methods, may be mentioned the following:

¹ *Op. cit.*, p. 43.

² 'A propos d'une lapsus calami,' *Revue Philosophique*, XXI., 547, 1886.

³ 'Experimentelle Untersuchungen der visuellen und akustischen Erinnerungsbilder, angestellt an Schulkindern,' *Archiv f. d. gesamte Psychol.*, 1905, IV., 4.

The visual type can easily change the order of material presented, while this is a difficult task for the auditory-motor type. It was found by Binet¹ in comparing Inaudi with another celebrated mathematical prodigy, Diamandi, that the latter, who seems to have been distinctly of the visual type, learned figures in any order whatsoever. Under such conditions Inaudi was at a great disadvantage, and succeeded in solving the problem only by using complicated aids. To take advantage of this essential difference between the visual and the acoustic-motor type Titchener² suggests the following test:

"Let O. learn a square of twenty-five figures or letters. If he is visual he can repeat the figures in any order,—by diagonals, spiral fashion, etc.,—almost as easily as he can repeat them line by line; if he is auditory or auditory-motor he will stumble and hesitate when called to travel out of the order of learning."

This test is probably in most instances valid. The writer believes, however, on the basis of his own introspection, that it is possible for a person of an extreme motor type to get certain kinæsthetic cues that serve the motor minded very much as spatial imagery does the individual of a visual type, in locating his material in various orders.

Meumann maintains that the acoustic-motor type is much more rapid in learning than is the visual, but that on the other hand the former is less accurate than the latter and that the acoustic-motor is also a more rapid forgetter than is the visual type. He observes, however, that these differences disappear in subjects of superior intellectual ability and that in such cases the rapid learner is not necessarily the rapid forgetter.

Vividness of imagery in a subject and the occurrence of hallucinatory experiences during waking life and sleep, have been taken by many to indicate the character of the imagery possessed by the person. Fechner, in his account cited above, mentions the existence of hallucinatory experiences as indicating vividness of imagery. Binet³ states that Féré could "imagine a red cross so vividly as to see afterward, on a sheet of paper, a green cross." June E. Downey⁴ has reported a similar fact, experimenting with naïve subjects. Whatever may be the truth of these assertions, I wish to urge that hallucinatory experiences of whatever sort, are not to be taken as criteria for determining the customary ideational processes employed in a person's thinking.

¹ *Psychologie des grand calculateurs*. Paris, 1894.

² *Op. cit.*, p. 401.

³ *The Psychology of Reasoning* (translated by A. G. White), Chicago, 1899.

⁴ *PSYCHOLOGICAL REVIEW*, 1901, VIII., 421.

As I have maintained elsewhere,¹ the mental image is not to be confused with an illusion or hallucination. It has an entirely different function in our mental life than have these false perceptions. The fact that the latter exist may indeed indicate that effective mental imagery is weak just as well as that it is unusually strong. In the case of the writer there seems to be absolutely no connection between vividness of imagery and the predominating type used in thinking. I find not the least difficulty in recalling mentally, rich colors, and I have often experienced just before falling asleep, visual hallucinations of a most pronounced character. I have elaborate visual dreams and have been able to get a complementary image from a memory image. Yet I seldom employ visual imagery in my thinking. In learning a word series I seldom see it as printed or written, my thinking being almost exclusively motor. Further, I have on several occasions experienced auditory hallucinations, but have, as far as I can discover, never had an auditory image. I recently experienced a most vivid taste dream, but I am reasonably certain that I have never used taste imagery in any of my thinking.

The discussion up to this point may be summed up as follows:

1. It is impossible to determine absolute ideational types in most individuals, because such pronounced types exist only in the man of genius, or in the abnormal or exceptional individual. All that can be done is to determine the predominating type of a given individual for a certain kind of material. The predominating type of thinking for an individual may vary markedly with the material and with the manner in which it is presented, so that an individual cannot be said to have a predominating type for all situations.

2. The determination of ideational types is further complicated by the difficulty of obtaining unequivocal methods for such determination.

3. The most trustworthy method is that of introspective analysis in its various forms. With a trained subject it is far more reliable than any objective methods of determining ideational types, and the greatest value of the objective methods in most cases is that they give opportunity for accurate introspections under controlled conditions.

4. Most of the objective methods are open to more or less serious criticism, and not one of them can be relied on alone as final.

5. These methods, in most instances, hardly show more than that one person is superior to another in a certain ideational process; that he is, for example, a better visualizer than another person tested under like conditions. It is much more difficult to determine whether a

¹ 'The Nature of the Mental Image,' *PSYCHOLOGICAL REVIEW*, 1908, XV., 158.

given person is superior in visual, motor or auditory imagery, because of the extreme difficulty of making the tests for these three types comparable.

6. While it may be possible to distinguish between visual and auditory-motor imagery, it is extremely doubtful if any objective test can be devised to determine conclusively whether a person thinks in auditory as distinguished from speech-motor images. Binet, for example, classed Inaudi as auditory and Meumann concluded that he was speech-motor. In my own individual case, I would respond well to most of the so-called tests for auditory imagery, and yet, in this type of ideation, I am markedly sub-normal.

The whole question of motor imagery is one which is still in a very unsatisfactory state. It is quite clear that there is no general motor type, since a person may be speech-motor without at the same time being hand-motor. Further, there is another type of motor-imagery which, as far as I know, has up to date passed practically unrecognized. It is a type which does not confine itself to the imagery set up by the organs of speech, or by the muscles of the arm, hand and fingers in writing. It is a type which expresses itself in more general motor attitudes and includes all sorts of kinæsthetic images that suggest the individual's relation to a situation and which are the mind-stuff of meaning. It is in such images as these that the writer does a large part of his abstract thinking. This thinking is not imageless by any means, but it does not have the rich ideation of concrete visual or auditory imagery. It is nevertheless substantial and highly important. To detect by purely objective methods such a type of ideation would, I believe, be difficult—indeed, it seems generally to have escaped the introspective analysis of trained observers. In considering motor imagery it should further be kept in mind that much of the so-called visual imagery is not actually such, but is really either the kinæsthetic sensations or imagery due to muscular adjustments of the eyes in accommodation, convergence and orientation of objects in space.

Objective methods of determining memory types are, however, needed, especially in the field of experimental pedagogy, in which a knowledge of the ideational types of children would be most serviceable in the technique and economy of learning. I cannot believe that here the tests advocated by Meumann would be of final validity. He suggests that children be tested for their ideational types as follows: 1. Ask them to write down a list of words characterized by sound, color, etc., five minutes being assigned for the task. 2. Determine whether the visual or oral method of presentation is the better. 3. Ask the children to write down the first idea that comes after a

stimulus word. These methods have already been criticised and found defective for adults. They are even more inadequate for children.

In the face of this uncertainty what may be done? Two criteria may, I believe, be employed for selecting adequate tests for ideational types. The first is that the test determined upon for any particular type should prove itself when employed with an observer known to be clearly of that type; the second is that the various tests should be in agreement with each other. I believe that the next step to take is to discover by careful investigation, in which the introspection of the subject is the chief guide, as many individuals as possible who seem to have marked visual or acoustic-motor types of thinking. An attempt should be made to find subjects of both sexes and of various ages. The next step is to use the various methods now known, or which may be devised, to test out these subjects. Those tests which objectively show the known ideational types of the subjects under investigation may be kept and then further tested out for consistency.

Up to the present time no such consistency is apparent in most of the tests employed. Some years ago Alma Bell and Loretta Muckenhaupt¹ tested the mutual consistency of the various methods given in Titchener's psychology for the determination of ideational types. These tests are, without doubt, the best single collection to be found, and they were considered by the writers of the article to have been shown fairly consistent. A reading of the results of the experiment does not leave the impression that the consistency was as great as should be demanded for standard tests. When it is remembered further that the tests were employed with trained subjects and that the introspections accompanying the tests are by far their most important feature, it will be seen that we are still far from possessing a series of tests that can be in any way relied on for use with unskilled subjects, especially when tested in groups.

There seems to be no valid reason, however, if *a priori* assumptions are left aside and the methods are tested out as has been suggested above, why a considerable number of valid methods of an objective sort may not ultimately be devised which shall conclusively determine whether a given subject under certain conditions employs predominantly in his thinking visual or auditory-motor imagery; if the former, whether it is concrete or verbal; if the latter, whether it is speech-motor, hand-motor, or motor in the sense of a more comprehensive kinæsthetic ideation.

¹ 'A comparison of methods for the determination of ideational types,' *American Journal of Psychology*, XVII., 121-126, 1906.

ON THE RELATION OF THE INTENSITY OF CHROMATIC STIMULUS (PHYSICAL SATURATION) TO CHROMATIC SENSATION.

BY A. H. MUNSELL,

Massachusetts Normal Art School, Boston.

The three dimensions of color are value, hue, and chroma or saturation or hue intensity. Of these the first has long been known to follow, at least approximately, the Weber-Fechner law of the relation between intensity of stimulation and sensation;¹ nothing has been reported concerning this relation for the two other dimensions, and indeed it is difficult to imagine how this problem can be stated for the second dimension, hue. The third dimension, however, chroma, is well suited to investigations of this relation, and it is my object to report in this paper certain simple experiments upon this subject.

The experiments have been made in every case with two circular discs of colored paper, formed from one homogeneous sheet, and cut as shown in Fig. 1. The disc represented by *A* is so cut that when spun each successive concentric ring, from the center out toward the circumference, contains a smaller proportion of the colored paper than its predecessor, the excised portion of each ring proceeding from center to circumference being 0, $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ of its total area. These ratios constitute a geometrical progression corresponding to the Weber-Fechner law.

Such a disc, when placed upon a white background and spun, produces with most colors a well graduated progression of concentric rings diminishing in chroma (saturation) and increasing in value from the center to the circumference. This experiment shows that in this case of simultaneous variation of two dimensions there is approximate accord with the requirements of the law of Weber and Fechner.

If now the background be changed to a neutral gray of the same value as that of the disc itself, a change which prevents variation in value and leaves but one variable, chroma, the effect of spinning is much altered. The concentric rings now present a very irregular progression of chroma, in that the chroma diminishes at first very little as

¹ Helmholtz, 'Handbuch der physiologischen Optik.' Hamburg, zweite Auflage, 1896, pp. 384-480.

compared with the diminution at the circumference. In this case the variation is not that required by the law.

Disc *B* is so cut that the excised portion of each ring proceeding from center to circumference is 0, $\frac{1}{3}$, $\frac{2}{3}$, $\frac{3}{3}$ and $\frac{4}{3}$ of its total area, an arithmetical progression. When the above experiments are repeated with this disc it is found that with the white background the pro-

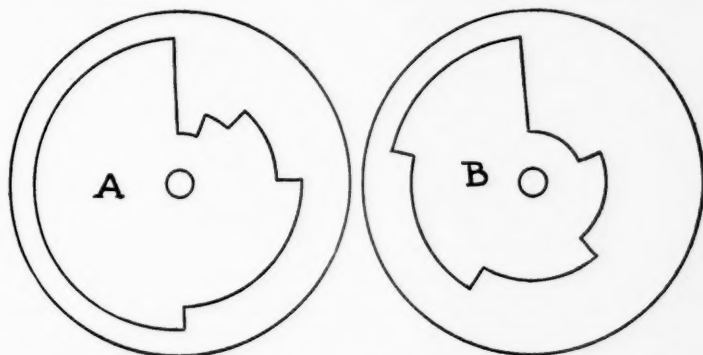


FIG. 1.

gression of chroma sensations is very irregular, the chroma diminishing rapidly at first and then more slowly. With the gray background an even progression of chroma is obtained.¹

For purposes of demonstration the experiments may conveniently be carried out as follows: disc *A* is placed on the white background, disc *B* on the gray background, and both are spun. The result is an even chromatic progression in both cases. Next disc *A* is placed on the gray background, disc *B* on the white background, and the spinning is repeated. In this case neither progression is even. The experiment is most satisfactory with either red or blue discs of rather low value.

These experiments show clearly that chroma sensation and chroma intensity (physical saturation) vary not according to the law of Weber and Fechner, but nearly or quite proportionately, and in accordance with the system employed in my color notation.²

¹ Extensive quantitative experiments with a variety of colors are now being carried out in the hope of extending our knowledge of the laws of variation of the two dimensions here considered.

² Munsell, A. H., *A Color Notation*, Boston, 1907.

PSYCHOLOGICAL LITERATURE.

PSYCHOLOGY OF SKILL.

The Psychology of Skill, with Special Reference to Its Acquisition in Typewriting. WILLIAM FREDERICK BOOK. University of Montana Bulletin 53, 1908. Pp. 188.

This admirable study of learning as exemplified in typewriting is of special significance because of its excellent analysis of the various stages of the process. Short cuts, which have come to be one of the most striking features of the early stages of learning, are discussed in detail and in a most entertaining and instructive manner. At the outset, in learning, associations are formed some of which have been previously used in other connections. Learning at this stage is slow and laborious, but soon by a process of elimination and reorganization useless accessories drop out and energy becomes more directly available for the accomplishment of the work in hand. Reorganization of elemental habits goes hand in hand with the perfection of the simpler habits themselves and, as the learner progresses, the identity of the latter is gradually lost in the higher order of habits which develop through this process of reorganization. For the teacher, who is more interested in the way in which these short cuts are made than in a psychological examination of their details, Book emphasizes the importance of careful instruction at the moment when need for it is felt. He agrees with Swift that economic methods are adopted unconsciously. This, of course, makes it important for the teacher to follow the work of each pupil in order to recognize immediately any new adaptation lest uneconomical methods become habitual.

The curves obtained by Book have the same general form as those found by other investigators. Irregularity from day to day and from week to week characterizes the progress. The explanation of these fluctuations in efficiency Book finds in a variety of causes. The physiological condition of the subjects, due to the amount and character of food and sleep, influence of the weather, and fatigue from other causes than the labor of the experiments, play their part, but the principal cause, in Book's opinion, is lapse in enthusiasm and the relaxed attention which follows. The chief reason given for this belief is that the pulse rate is decreased during these periods of arrest, an indication of

lessened effort. The relation between pulse rate and progress is certainly important; but may not the slower pulse be due to the economizing of energy in practicing details which must be automatized before further advance can be made? It is suggestive in this connection that all of Book's curves, including those of the investigator himself, who certainly would put as much effort into the work as seemed productive of results, show plateaus of greater or less length.

Book found the same increase in skill after cessation of practice as others have observed, but he does not accept the usual explanation of subconscious neural activity. The increase in skill found in his memory tests he ascribes "to the disappearance, with the lapse of time, of numerous psycho-physical difficulties, interfering associations, bad habits of attention, incidentally acquired in the course of the learning, interfering habits and tendencies, which as they faded, left the more firmly established typewriting associations free to act." The difficulty in accepting this explanation lies in the fact that when once the skill has been acquired all of these difficulties have been eliminated, as is shown by the even skill of the expert, and yet when the memory test is made some of the old obstacles to progress reappear but are quickly overcome, while the greater score indicates increased skill.

Book rightly attaches great importance to the hygiene of learning. "It is not what the learner would like to do that determines his rate of progress in learning, but what his mental and physical conditions at the time will let him do." When the subjects were not in good form for the work more mistakes were made, less was accomplished, a feeling of dislike for the work developed, and, more important, perhaps, than all else, the learners dropped down into the earlier and less skillful habits of work. The newer methods of forging ahead and achieving results, which had led to short circuiting, were no longer operative, and so the time was apparently not only lost but, in addition, bad habits were acquired which had to be sloughed off by patient work on the better days. If this is true of adult learners who have a scientific interest in the work in which they are engaged, with the enthusiasm that it engenders, it certainly has much more force with children, and raises again the question of whether the present rigid curriculum of the day is educationally economical. Would it not be better to have a more flexible program which could be easier adapted to the daily needs of individual children?

Altogether these experiments are most suggestive and cannot fail to stimulate investigation along several lines.

EDGAR JAMES SWIFT.

WASHINGTON UNIVERSITY, ST. LOUIS.

DEVELOPMENT AND LEARNING.

Studies in Development and Learning. E. A. KIRKPATRICK.

Archives of Psychology, edited by R. S. Woodworth, No. 12.

New York, Science Press, 1909. Pp. 101.

Under this title the head of the department of psychology and child study in the Fitchburg Normal School publishes theses prepared by members of the advanced class of 1907. These theses were based upon data secured by a series of measurements and tests extending over a period of five years. The studies are well worked out and some of the methods employed are ingenious.

Tests and measurements showed that while boys are at six heavier and taller than girls, the girls exceed the boys at thirteen, passing them in weight at eleven and in height at ten; but boys have greater chest and head measurements throughout. In a comparative test, it was found that auditory memory is slightly better than visual up to the age of eight or nine and that the reverse is the case later. The memory of girls is a little better than that of boys. In testing quickness of perception and movement, it was found that children were considerably more efficient with each year up to nine, with less increase of power up to eleven or twelve and hardly any later. Girls were found from eight to ten per cent. quicker than boys. Children at any age were not only better than they were a year before, but also better than preceding classes had been at the same age but with one year less of practice.

The development of the artistic sense was traced through decorations of portfolios made by children in October and June of five successive years. The bright colors used by young children gradually changed to neutral tints, though older girls still used colors more than did the boys. They began with designs based on geometric forms and later used more nature forms and objects associated with their play, work, seasons, etc., and considerable lettering in the upper grades. In penmanship, few more than half of the pupils showed improvement from October to June or from either date in one year to the same in the next, and a few pupils lost ground in each case. From June to October, more than half remain stationary, while about equal numbers gain and lose respectively. Between nine and twelve is a period of little or no progress. Then girls improve again, but boys generally do not until still later, if ever.

A study of the judgments of children by teachers made by comparing reports of different teachers led to the conclusion that teachers

generally judge children in the same way and correctly, unless there is some irregularity in the physical and mental growth of the children.

Investigations of the curve of learning gave the usual conclusion that the decrease in time required to do a certain task diminishes rapidly with practice at first: then more slowly and finally not at all.

In testing visual memory, through reproduction of figures shown to pupils, it was found that motor, associative, visual and verbal methods of memory were all used,—usually more than one combined. Children remember wholes and use the motor methods much, while adults study details more and depend more on association. Hence adults are much more superior to children in correctness as to details than in general form and proportion. The results were found much better when a motor method of memorizing (drawing on desk with finger) was prescribed than when visualization was depended upon or the child allowed to choose his own method. This suggests the wisdom of practice in drawing maps, manual training and laboratory methods.

One investigator concluded, perhaps somewhat unjustly, from answers given by pupils in upper grades and high school that 82 per cent. use some form of merely verbal memory. Rather more than half of the pupils spoke of certain tests by which they determined when they knew their lessons, and these pupils had the highest marks. Reciting by sections or answering questions expected from the teacher were the commonest tests. It is interesting to note that the lower the marks received the longer time was spent in the preparation of the lesson. The lowest marks were received by boys who spent 150 minutes of time on lessons in the school-room, while the highest were received by pupils who spent 60 minutes in uninterrupted home study on the same lessons.

In learning music, it was determined that the best method of all is reading the score and playing at the same time,—the ordinary practice; while the poorest was listening to some one else play. In learning, children thought more by letter, syllable or number symbols, and adults relied more on the visual method, imaging either the keyboard or the score.

An attempt was made to discover children's ideas of right and wrong, by asking those of different grades to tell the worst thing a boy or girl can do and why it is culpable. Standards vary with age and sex. Disobedience appears the worst of sins to the young child, acts likely to ruin reputation to adolescent girls, dishonest practices to adolescent boys, etc. Girls care most for what people will think

of them, boys for faithfulness to whatever law they recognize as a standard. The teacher may learn much from such a study of how to choose the strongest influences for boys and girls of all ages.

W. W. EARNEST.

UNIVERSITY OF ILLINOIS.

THE FRANKFORT MEETING OF EXPERIMENTAL PSYCHOLOGISTS.¹

The third *Kongress für Experimentelle Psychologie* was held at Frankfort in April, 1908. The society is in a vigorous condition, and has an active membership of one hundred and twenty-eight. Professor G. E. Müller presided over the meetings, while Professor F. Schumann acted as secretary, and published the report of the proceedings. As in the preceding year, the program contained a number of *Referate* of a general nature besides the customary briefer papers upon more specific topics. The American psychologist is struck by the wide range of subjects covered by the German society; but more striking still is the efficient and thoroughgoing fashion in which the German society handles its problems. In the papers and discussions a high standard of excellence was maintained throughout; and the report of the proceedings is a valuable contribution to the literature of psychology.

The general reviews upon assigned topics were contributed by Professors Edinger, Claparède, Pick, Bühler and Specht.

L. EDINGER. *Die Beziehungen der vergleichenden Anatomie zur vergleichenden Psychologie*. Pp. 1-22. It has long been felt in many quarters that the anatomist has little of real value to offer to the psychologist. As a matter of fact, the two sciences have much in common, and their progress has brought them into closer relationship with each other. Indeed, the anatomist's knowledge of the brain possessed by any animal enables him to predict a majority of the mental functions of which the animal is capable.

It is convenient to regard the brain of the higher vertebrates as being composed of two parts: the *palæencephalon*, which is found throughout the animal series, and the *neencephalon*, which does not appear below the fishes, and which reaches its maximum development in man. (The *neencephalon* is apparently identical with the cerebrum, while the *palæencephalon* may be said to coincide roughly with the sub-cerebral centers.)

¹ *Bericht der III. Kongress für Experimentelle Psychologie*. F. Schumann, Leipzig, Barth, 1909. Pp. xxii + 263. 9 M.

The form and structure of the palæencephalon is such as to make it appropriate for the receiving of impressions from without, and for the transmission of impulses onward to the muscles. No part of this organ can be excised without producing disturbances in the behavior of the animal; and its parts are found to be developed in proportion to the demands made upon it by the life of the animal. For example, the cerebellum disappears in certain sedentary forms while in strong swimmers and fliers it attains to a considerable bulk.

The fishes are capable only of palæencephalic behavior. They possess a variety of reflex and instinctive functions; and at this level of the scale animals are able to modify their reactions in a very limited fashion. Thus, while the fishes may be trained to avoid dangerous situations and to approach food, certain allied forms, which are so shy as to flee from shadows, remain unmoved in the presence of much more intensive stimuli, which have no biological significance for them. It is characteristic of palæencephalic behavior that so long as the stimulus acts in unchanged form the reaction ensues in stereotyped fashion. If a moving object constitutes the food-stimulus, all moving objects arouse the seizing reaction. Moreover, if the first attempt to seize the prey should prove unsuccessful the reaction ceases then and there, and the animal remains quiescent until it is restimulated.

The advent of the neencephalon in the animal series is attended by a complete change in behavior. The animal is no longer dependent upon the chance stimulation of the moment; prey is now sought and pursued. Not only is it possible, at this stage, to form associations and to recognize, but there is evidence of a capacity to anticipate what is about to come. It is a significant fact that the rise and development of the neencephalon is paralleled by a rise and development of associative functioning; and that the maximum development of the palæencephalon—in birds—is attended by a maximum development of instinctive behavior.

In the fishes, then, we have representatives of purely palæencephalic animals; in reptiles and in birds a rudimentary neencephalon coöperates with the palæencephalon; while in mammals the neencephalon has reached such a development as to lead one to expect that the reflexes and the instincts are here subordinated to the intelligence. And this expectation is fulfilled in all mammals where the neencephalon has come to outweigh the remainder of the total brain-mass.

E. CLAPARÈDE. *Die Methoden der tierpsychologischen Beobachtungen und Versuche*. Pp. 22-59. A systematic summary and criticism of the methods employed in comparative psychology, with numerous illustrations from the literature.

A. PICK. *Ueber das Sprachverständnis vom Standpunkte der Pathologie aus.* Pp. 59-93. A historical sketch, with full bibliography, of the investigations in this field. The understanding of speech is a synthetic function which includes a variety of component processes. Sherrington advocates the view that the auditory organ represents only a very highly developed organ in the series of distance-receptors which are connected with one another by a complex brain structure for the purpose of adaptation to environment. And from this point of view the function of the understanding of speech may be regarded as a condensation which is carried on from the cochlea to the cortex. And if determinations of this process may be regarded as showing that it consists of numerous stations, one cannot be surprised when one remembers that so simple a function as cutaneous sensitivity demands the presence of no less than five stations (v. Monakow). It was my problem to discover the elements whose synthesis constitutes this cochlea-to-cortex process. The examination of pathological cases enables one to determine what centers correspond to particular absent or present elements, and to discover the reciprocal relations obtaining between the individual processes. The chief contribution which pathology has been able to make in this domain has to do with the understanding of verbal sounds; and it seems possible that pathology can still further aid psychology by indicating the more promising points of attack upon the problem.

K. BUEHLER. *Ueber das Sprachverständnis vom Standpunkte der Normalpsychologie aus.* Pp. 94-130. The auditory image of a word is a complex structure in which the following elements are blended into a unitary whole: the melody of the word, the distribution of ictus, certain definite temporal relations, and a qualitative mixture of tonal and noise elements. But even when the structure or composition is understood there still remains the problem of its rise or origin in consciousness. A synthetic procedure promises the best results. But serious difficulties are encountered: lack of experimental material, lack of experimental method (no instantaneous method of presentation similar to tachistoscopic exposure). Moreover, different verbal constituents (vowels and consonants) are apprehended with different degrees of facility; and the context has an influence upon the apprehension of individual words. If we ask what we do when we understand the meaning of words, phrases and sentences, we find we have a complex problem which is related with the general problem of the psychology of meaning. We do know, at least, that we usually mean more than we ideate. And it frequently happens that the sen-

sory content stands at the center of the meaning consciousness; but it also happens that the idea may lie so far from the center as to seem to be no more than a mere concomitant phenomenon. After all, we know but little of the thought consciousness. There is probably a conscious relation between the content which constitutes the meaning consciousness, and the auditory image of the word; indeed, certain investigators regard this relation as the essential characteristic of the meaning consciousness. The sentence has a meaning of its own which is more than an aggregate of the meanings of the individual words. And, indeed, the meanings of the words themselves are modified by the meaning of the sentence as a whole.

W. SPECHT. *Das pathologische Verhalten der Aufmerksamkeit*. Pp. 131-191. A summary, criticism and evaluation of investigations which have dealt with the pathological relations of the attention. Ribot regards attention as a form of monoideism, or concentration of consciousness in a single direction. Attention is regarded as a simple mechanical device. Peripheral stimulations give rise to sensori-motor excitations, and these in turn produce an intensification of the mental content—and that is attention. All of the pathological conditions of attention—its atrophy, hypertrophy, and congenital weakness—are traceable to disturbances in sensori-motor excitability. It may, however, be urged against Ribot's conception that mental phenomena are not explained by translating them into physiological terms. De Sanctis has done valuable service in determining certain phenomena of attention, but he has contributed nothing to the psychological analysis of its pathological conditions. Ziehen has brought forward a conception which abounds in contradictions, which are discussed in detail by Specht. Kraepelin's presentation is the most satisfactory to be found in the literature. Any attempt to evaluate current theories of attention in the light of pathological data reveals the fact that all of the theories are unsatisfactory. The author refers to the work of Aschaffenburg, Lipmann and Isserlin, and closes with the statement that the determining tendency or *Einstellung* of attention is to be regarded as a directing of the immediately experienced I toward a definite goal which need not itself be intuitively given. In this regard attention manifests itself as will.

I. APPARATUS.

Marbe demonstrated his ingenious method of recording tones (pitch, intensity, clang-tint, and duration) by means of a deposit of smoke from a Koenig flame apparatus.

Alrutz illustrated the abnormalities of color vision by means of a series of autochrome plates, and demonstrated the Thunberg and the Alrutz algesimeters.

Rupp (Spindler & Hoyer) demonstrated a color mixture with variable sectors, a distance variator, a spectral apparatus, a tonometer and a vowel apparatus. He displayed a collection of nonsense syllables (Müller and Schumann) which his firm has put upon the market.

II. ANATOMY AND PHYSIOLOGY.

C. U. A. KAPPERS. *Ueber die Bildung von Faserverbindungen auf Grund von simultanen und sukzessiven Reizen.* Pp. 195-199. Comparative neurology shows that the receptor regions play an important part in cerebral development. The law of association by contiguity in time is a fundamental law of brain structure.

F. O. SCHULTZE. *Die Bedeutung psychologischer Fehlerquellen bei Blutdruckmessungen nach Riva-Rocci und v. Recklinghausen.* Pp. 211-212. Most errors are due to an insufficient number of readings, and to the fact that the variable height of the mercury is not obscured from the observer. When this factor of suggestion is excluded readings become more uniform.

III. GENERAL.

J. PLASSMANN. *Beziehungen zwischen der Astronomie und Psychologie.* Pp. 199-202. A discussion of time estimations and photometric determinations, and a reiteration of the fact that astronomy confirmed Weber's Law before psychology formulated it. The data which have accumulated in astronomical observations are of value to the psychologist, especially for the reason that these observations were not made *ad hoc*.

IV. SENSATION.

A. GUTTMANN. *Farbensinn und Malerei.* Pp. 234-6. To what extent does individual variation in color vision play a part in the production, and in the estimation and enjoyment of paintings? The author's investigations show that anomalous color vision is of negligible significance in both these regards. Artistic genius is a matter not of sensation but of the higher mental functions; and cases are found where the possessor of an anomalous color system has become a distinguished colorist (three such cases are reported by Guttmann). While the anomalous individual may fail to appreciate certain fine gradations of coloring, yet these individuals are so rare as to be negligible by the æsthetician and the artist.

C. MINNEMANN. *Beobachtungen an kurzdauernden Lichtreizen*. Pp. 252-6. A discussion of data obtained by different methods of heterochromatic photometry. The flicker method is of doubtful value unless extreme care is taken to control the temporal conditions of stimulation.

G. RÉVÉSZ. *Ueber Orthosymphonie (eine merkwürdige parakustische Erscheinung)*. Pp. 243-4. A remarkable case of abnormal hearing. Clangs between e^3 and d^4 -sharp were heard as g^2 -sharp or g^3 -sharp; in another case e^3 - b^2 were heard as f^2 -sharp, c^3 - f^2 as c^3 , f^2 -sharp- b^2 as f^2 -sharp, and c^4 - e^4 as c^4 . A mistuning of individual clangs in chords was not detected by the observer.

V. PERCEPTION.

A. AALL. *Ueber den Massstab beim Tiefsehen*. Pp. 203-6. Advocates of the empiristic or genetic view of space perception hold that objects seen in double images cannot be localized definitely; while the nativist contends that such localizations can be made through the medium of retinal 'feelings of space.' Aall attacks the problem by means of an apparatus (the bathoscope) which enables him to present three vertical rods at variable distances from the observer. The procedure consists in fixating the rod which stands at an intermediate distance, and varying the position of the nearer and farther rods in such a manner as shall give a definite expression to the observer's estimate of the relative distance of the three rods from each other. The results are, unfortunately, reported in such condensed form as to be unintelligible to the reviewer; but they are held by the author to confirm the nativistic assumption of a retinal clue to distance.

W. STERN. *Die Entwicklung der Raumwahrnehmung beim Kinde*. Pp. 239-242. The acquisition of spatial relations is a gradual development which originates from the 'Urraum' of the mouth region. At this region are made the earliest differentiations of space, and here originates, within the first few weeks, a definite sensori-motor reaction—a touch upon the cheek being responded to by a turning toward the stimulus-object. In the development of spatial perception 'Nahraum' is the first to emerge from the chaos. This may be represented by an approximately hemispherical volume whose center is the mouth and whose radius is about 30 cm. Within this region objects are localized, within the first few weeks, by means of the mouth and of vision: but the hand soon becomes a localizing agent also. The coördination of hand and eye is a product of experience; but it is

acquired in the first three months. Infants do not reach for objects which lie beyond the 'Nahraum.' The ear becomes an instrument of 'Fernraum' localization during the second three months; but the spatial perception of distant objects is imperfect until locomotion is established.

Pictures which but partially resemble objects are correctly recognized at the beginning of the second year. Contour is the chief factor in this primitive recognition, but the internal details furnish a secondary criterion. Color, size and even spatial position are relatively insignificant factors at this stage. An appreciation of perspective is present from the end of the second year.

Children are indifferent to spatial position long after spatial form has been acquired. The picture-book is enjoyed equally well in inverted position. Even at the age of five years letters and figures are written in haphazard position,—some being turned through ninety degrees, others through one hundred and eighty, while some are written in mirrored form.

VI. ASSOCIATION AND MEMORY.

O. LIPMANN. *Zur Beurteilung der Reaktionen bei Gedächtnis- und Aussageversuchen.* Pp. 212-218. In investigations of memory it has been customary to regard all errors as being of equal magnitude, and to enumerate them as so many units. Witasek however has proposed a method of computation which assigns different values to different sorts of errors. The author presents a detailed criticism of Witasek's plan, pointing out that such a scheme is false in principle, that it yields nothing more than is yielded by a simple enumeration of errors, and that experimental data obtained by the investigators of memory are enlightening in their gross form even if they do not admit of being evaluated in terms of a system of value coefficients.

A. MICHOTTE. *Gedächtnisversuche mit mehrfachen Assoziationsrichtungen.* Pp. 259-263. An investigation of the recall of logical relations, and of the relative efficiency of memory for different sorts of material. Selected pairs of words were presented visually, and the observers were asked to apprehend their logical relations. The results reveal the fact that recall may be either direct or mediated. In the latter case the intermediate process was usually a mental image, but it frequently happened that the sole intermediate bond was a consciousness of relation. The consciousness of relation may be of two sorts: a genuine mediating process, or a mere concomitant phenome-

non; but in either case its presence furnishes an aid to memory. The observers varied but little in memorial efficiency so long as logical relations were employed as material; but when numbers were substituted for the words a wide individual variation appeared.

F. E. O. SCHULTZE. *Bericht über Assoziationsversuche des psychologischen Instituts der Frankfurter Akademie*. P. 257. The investigation of Thumb and Marbe was continued in a series of mass experiments, whose results throw light upon the influence of age upon association. The laws formulated by Thumb and Marbe were confirmed; and it was even found that children show a preference for associations between similar word groups. This is particularly true of adverbs of time and place, and of numbers.

Recent writers have reported that reaction experiments may be employed to surprise a suspected criminal into a betrayal of his guilt. Schultze submitted this method of criminological diagnosis to a test. He reports that the method has but a limited value.

W. PETERS. *Ueber Erinnerungsassoziationen*. Pp. 245-7. A word was presented orally, and the observer was asked to report a personal experience of a definite sort. He also recorded the affective tone of the memory and of the original experience. The results indicate that all four observers have a marked tendency to recall pleasant experiences. In the memories, however, the indifferent hedonic tone predominated, but here again the pleasant outnumbers the unpleasant. There is a large individual variation throughout. Memories of very recent events (up to two days) contain more unpleasant details and less unpleasant features than memories of very distant events (ten years).

N. ACH. *Ueber eine Methode zur Untersuchung der simultanen Assoziationen*. Pp. 218-226. Investigators of memory have dealt almost exclusively with successive associations. But conscious processes also manifest a marked tendency to associate simultaneously. The investigation of this sort of association is beset by peculiar difficulties in that the *Perseverationstendenz* and the successive associations introduce disturbing factors. Ach overcomes the difficulty by an ingenious variation of method. Complete and systematic changes in the temporal conjunction of his presented material (permutations of groups), an exceedingly brief exposure time (150-200 σ), a careful choice of material, and precautionary instructions to his observers seem to fulfil the necessary conditions of procedure. His method demanded a special form of exposure apparatus — and Ach devised an apparatus which embodies the combined principles of the tachistoscope

and of the revolving disc. The Hipp chronoscope was introduced as a supplementary apparatus.

Ach presents only a preliminary statement of his results, — from which it may be gathered that certain laws of successive association (retroactive and associative inhibition) are valid also for simultaneous associations.

VII. THE THOUGHT PROCESSES.

A. GRÜNBAUM. *Ueber Abstraktion des Gleichen*. Similar figures were selected from a heterogeneous group. Introspection shows that the experience of abstracting contains two widely different processes. These may be described as simple disjunction, and consciousness of relation; and the former is independent of the latter because in some cases the disjunction of the figures was accomplished without any consciousness of relation being present. A second series of experiments resulted in establishing a distinction between apperception and abstraction. Yet the essential features of the abstraction may best be described in terms of internal attention (Külpe). Yet another group of experiments furnished an analysis of the experience of similarity (*Gleichheit*) into two parts, — a consciousness of relation, in the narrow sense, and a group of concomitant processes such as mental start or shock, relief, satisfaction and the like. The consciousness of relation depends upon the sort of datum which constitutes the basis of the relation; and various sorts of relational bases may be distinguished.

E. DÜRR. *Ueber die experimentelle Untersuchung der Denkvorgänge*. Pp. 232-4. The methods and results of recent investigations of the thought processes are summarized and criticised. The criticism is chiefly directed against Bühler's 'Tatsachen und Probleme.' Dürr points out that investigators have not been careful to distinguish between 'thinking' and 'reflecting upon,' nor indeed have they correctly understood the meaning of the former which has constituted the subject-matter of their investigations. Bühler attempted to determine the nature of thought by approaching it from single abstract points of view; his analysis into *Regelbewusstsein*, consciousness of relation and intention, does not solve his problem, because thought is much more than a mere aggregate of independent components.

Dürr holds that the only way to determine the nature of thought is to compare it with other contents of consciousness. Do thoughts contain non-sensational components? What is the relation of thought to these components? The author agrees with those who hold that something besides sensational factors is present in the consciousness of

space, time, similarity, movement, change and the like; and he believes that the discovery of the non-sensational component will reveal the nature of thought.

VIII. THE PSYCHOLOGY OF LANGUAGE.

A. THUMB. *Assoziationsversuche im Dienste der Sprachwissenschaft*. Pp. 247-8. The history of language shows instances of verbal forms which have been corrupted by other word-forms which are in some way related to them. The corruption could have arisen only through the medium of a mental association between the corrupting and the corrupted forms; and the question arises: What characteristics must a verbal association possess in order to be able to exert a contaminating influence?

The experiments of Thumb and Marbe show that associations such as would fulfil the philological conditions (give — take; difficult — easy) are just the associations which are preferred by most observers, that these ready associations have the briefest association-times, and that the association-time decreases with increased frequency of association. Later experiments confirm these findings, and demonstrate that the associations in question are characterized by immediacy. It is remarkable that these ready associations are a product of individual acquisition; the prevailing associations of children are not of such a character as would account for verbal corruption.

BRUNO EGGERT. *Sprachmelodische Untersuchungen*. Pp. 208-211. Selections from two authors were spoken into a Marbe recording apparatus. The results show that individuals differ in the pitch and the vocal range of their spoken discourse, as well as in their preference for certain pitches. The 'curve of melody' reveals an alternation of pitches in ascending and descending phases, both of which differ in magnitude and in direction. The descending phase is of greater magnitude and of longer duration than the ascending.

PAUL MENZERATH. *Psychologische Untersuchungen über die sprachliche Kontamination*. Pp. 249-252. A historical sketch of the problem, and a description of the author's procedure. No statement of results.

IX. ABNORMAL PSYCHOLOGY.

S. ALRUTZ. *Halbspontane Erscheinungen in der Hypnose*. Pp. 244-5. When it was suggested to a hysterical patient that a definite part of his body became immobile it was found that the cutaneous sensitivity of that region was decreased, and similar changes occurred in the olfactory and visual senses. It was suggested to another

hysterical patient that he could feel pin-pricks in an insensitive region. Not only was this suggestion successful, but it was attended by a heightened sensitivity to pressure, temperature, olfactory and gustatory stimuli.

X. ÆSTHETICS.

FR. SCHMIDT. *Untersuchungen über die spontane ästhetische Empfänglichkeit des Schulkindes.* Pp. 258-9. Pictures were shown to school-children of various ages and degrees of intelligence; and an attempt was made to obtain a natural and unconstrained record of their spontaneous reaction to the æsthetic situation. Notwithstanding the serious difficulties of the method the author believes that the results indicate the existence of five stages of æsthetic development. The characteristic attitude at the lowest stage is largely sensual, but the later stages show the dawn of fanciful supplementation, *Einfühlung*, and æsthetic evaluation.

J. W. B.

WEBER'S LAW.

Das psychophysische Gesetz und der Minimalsehraum. R. v. STERNECK. *Zeitschrift f. Psychologie*, 1908, XLVII., 96-116.

Owing to our lack of knowledge about the processes arising in a nerve under the influence of external stimulation we do not know what is the stimulus in the proper sense of the word. From this comes that physical processes may be measured in very diverse units of measurement, so that a direct verification of Weber's Law is entirely out of question. In some simple cases, however, as, *e. g.*, in experiments with lifted weights, there is no doubt as to the unit in which the external stimulus must be measured, and it is exactly in those cases that Weber's Law is valid. The author suggests regarding this law as a postulate, *i. e.*, to require that the external stimulus be determined in such a way that this law holds. This is similar to the procedure of physics, where the law of conservation of energy is deduced from comparatively crude experience and where this proposition is introduced later on as a principle with which all phenomena must comply. The method of transforming the unit of measurement in such a way that the experimental results conform with Weber's Law is illustrated by the results of König and Brodhun on just perceptible differences of intensities of light.

The measurement of sensations is restricted to those cases where the sensation produces ideas of spatial or temporal quality, so that the

ideas resemble their objects in regard to these qualities. Let such a quality of an idea, which corresponds to the stimulus r measured in any unit whatsoever, be called r' ; we transform the unit of measurement of r in such a way as to conform with Weber's Law, obtaining $f(r)$ for r and $f(r')$ for r' . The question is whether the sensations conform with Weber's Law. Hillebrandt's experiments on space perception show that there exists a relation between actual and estimated space distances, *i. e.*, between sensation (estimated distance) and stimulus (actual distance). Two distances are just perceptibly different, if the difference between their binocular parallaxes is equal to the minimum of disparation. It is found that if these quantities are determined in a system of measurement which conforms with Weber's Law, the sensations conform with it too. The author believes that his results show the correctness of Meinong's interpretation of Weber's Law.

F. M. URBAN.

UNIVERSITY OF PENNSYLVANIA.

BOOKS RECEIVED FROM MAY 5 TO JULY 5.

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Program of the Association for International Conciliation, and sixteen other pamphlets, by various authors. New York, American Branch of the Association, 1907-9.

Poems of Personality. Second series. REGINALD C. ROBBINS. Cambridge, Riverside Press, 1909. Pp. 229.

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Two Extensions of the Use of Graphs in Elementary Logic. WILLIAM ERNEST HOCKING. Berkeley, University Press, 1909. Pp. 31-44.

La Criminalité dans l'Adolescence. G. L. DUPRAT. Paris, Alcan, 1909. Pp. 260. 6 fr.

The Social Will. EDWIN ANDREW HAYDEN. Psychological Review Monograph, No. 41. Lancaster, Pa., Review Publishing Co., 1909. Pp. 934. \$1.00.

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NOTES AND NEWS.

PROFESSOR BALDWIN has resigned his position in the Johns Hopkins University. He is advised to give his voice a prolonged rest from continuous lecturing. He will spend a year at least abroad (Present address: Banque Fédérale, Geneva).

DURING the coming year Professor Buchner will conduct the philosophical seminary at the Johns Hopkins University, with the assistance of Dr. Furry. Special lecture courses will also be given by Professor Dewey, of Columbia University, and Professor Tufts, of the University of Chicago.

THE present number of the BULLETIN, dealing especially with experimental psychology, has been prepared under the editorial care of Professor J. W. Baird.

WE have received the final announcement of the Geneva Congress of Experimental Psychology, containing the full program. The dates of meeting, general topics, and arrangements are as noted in our March number.

THE following are taken from the press:

DR. PERCY HUGHES has been promoted to the rank of full professor of philosophy and education at Lehigh University.

DR. S. P. HAYES has been made professor of psychology at Mount Holyoke College.

AT the recent commencement of Columbia University the degree of doctor of letters was conferred on Professor Mary Whiton Calkins, of Wellesley College.